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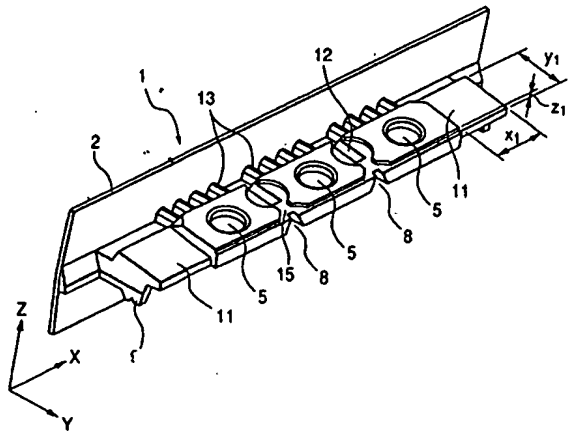
(54) Liquid ejecting recording head

(57) A liquid injecting recording head is constructed by a first substrate in which a discharging energy generating element for generating discharging energy for discharging a recording liquid is formed, and a second substrate which has a liquid flow path groove forming a liquid flow path by joining this liquid flow path groove to the first substrate, a concave portion communicated with the liquid flow path groove and forming a common liquid chamber for temporarily holding the recording liquid, and an orifice plate communicated with the liquid flow path groove and having a discharging port for discharging the recording liquid. The liquid injecting recording head is constructed by joining the first and second substrates to each other in a form in which the discharging energy generating element and the liquid flow path groove correspond to each other. The liquid injecting recording head is characterized in that both end portions of a face opposed to a face of the second substrate joined to the first substrate are formed to be thin.

FIG. 1A



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liquids of the common liquid chambers are mixed with each other in a worst case.

[0010] The reaching position of the liquid droplet is also shifted by slight warp of the second substrate and slight winding of a joining face of the second substrate to the first substrate, etc. caused as the second substrate is large-sized. In particular, when the second substrate is manufactured by injection molding, an important subject is to restrain this slight warp and winding.

[0011] Simultaneously, it is gradually required to accurately align the position of a center of the discharging energy generating element of the first substrate and the position of a center of the liquid flow path groove of the second substrate. When these centers are not in conformity with each other, the discharge of the recording liquid is unbalanced and this unbalance has an influence on the reaching position of the liquid droplet. In particular, foaming is unbalanced when the discharging energy generating element is a heating element of an electricity heat converting element, etc.

SUMMARY OF THE INVENTION

[0012] In view of the unsolved problems of the above prior art, an object of the present invention is to provide a liquid injecting recording head in which first and second substrates can be closely joined to each other easily and reliably at low cost and a high definition image can be obtained at high speed.

[0013] To achieve the above object, the present invention resides in a liquid injecting recording head constructed by a first substrate in which a discharging energy generating element for generating discharging energy for discharging a recording liquid is formed, and a second substrate which has a liquid flow path groove forming a liquid flow path by joining this liquid flow path groove to the first substrate, a concave portion communicated with the liquid flow path groove and forming a common liquid chamber for temporarily holding the recording liquid, and an orifice plate communicated with said liquid flow path groove and having a discharging port for discharging the recording liquid; the liquid injecting recording head being constructed by joining said first and second substrates to each other in a form in which said discharging energy generating element and said liquid flow path groove correspond to each other; the liquid injecting recording head being characterized in that both end portions of a face opposed to a face of said second substrate joined to said first substrate are formed to be thin.

[0014] The present invention also resides in a liquid injecting recording head constructed by a first substrate in which a discharging energy generating element for generating discharging energy for discharging a recording liquid is formed, and a second substrate which has a liquid flow path groove forming a liquid flow path by joining this liquid flow path groove to the first substrate, a concave portion communicated with the liquid flow path groove and forming a common liquid chamber for temporarily holding the recording liquid, and an orifice plate communicated with said liquid flow path groove and having a discharging port for discharging the recording liquid; the liquid injecting recording head being constructed by joining said first and second substrates to each other in a form in which said discharging energy generating element and said liquid flow path groove correspond to each other; the liquid injecting recording head being characterized in that digging-in concave portions are formed in both end portions of a face opposed to a face of said second substrate joined to said first substrate.

[0015] The present invention also resides in a liquid injecting recording head constructed by a first substrate in which a discharging energy generating element for generating discharging energy for discharging a recording liquid is formed, and a second substrate which has a liquid flow path groove forming a liquid flow path by joining this liquid flow path groove to the first substrate, a concave portion communicated with the liquid flow path groove and forming a common liquid chamber for temporarily holding the recording liquid, and an orifice plate communicated with said liquid flow path groove and having a discharging port for discharging the recording liquid; the liquid injecting recording head being constructed by joining said first and second substrates to each other in a form in which said discharging energy generating element and said liquid flow path groove correspond to each other; the liquid injecting recording head being characterized in that a length A of said second substrate in an arranging direction of the liquid flow path groove on a face of said second substrate joined to said first substrate is longer than a length B of the first substrate, and is also longer than an arranging length C of the discharging port and these lengths satisfy the relation of $(A-C)/2 \geq 1.1$ mm and $(B-C)/2 \geq 0.825$ mm.

[0016] The present invention further resides in a liquid injecting recording head constructed by a first substrate in which a discharging energy generating element for generating discharging energy for discharging a recording liquid is formed, and a second substrate which has a liquid flow path groove forming a liquid flow path by joining this liquid flow path groove to the first substrate, a concave portion communicated with the liquid flow path groove and forming a common liquid chamber for temporarily holding the recording liquid, and an orifice plate communicated with said liquid flow path groove and having a discharging port for discharging the recording liquid; the liquid injecting recording head being constructed by joining said first and second substrates to each other in a form in which said discharging energy generating element and said liquid flow path groove correspond to each other; at least one concave portion is formed on a face of said orifice plate joined to said first substrate.

[0017] In the liquid injecting recording head of the present invention, digging-in concave portions are preferably formed in both the thin end portions of a face opposed to a face of said second substrate joined to said first substrate. Further, both the thin end portions of a face opposed to a face of said second substrate joined to said first substrate and the digging-in concave portions are preferably arranged with bilateral symmetry with respect to a central line of said second substrate.

[0018] In the liquid injecting recording head of the present invention, said concave portion formed in said orifice is preferably arranged in each of positions corresponding to both end faces of said first substrate.

[0019] In the liquid injecting recording head of the present invention, the concave portion in said second

liquid supplied to the discharging ports are formed. The second substrate 1 also has a liquid flow path groove 4 and a liquid supply port 5. The liquid flow path groove 4 is located in accordance with the position of a discharging energy generating element and is communicated with one of the plural common liquid chambers 3 and is arranged to form a liquid flow path communicated with the discharging ports. The liquid supply port 5 is formed to supply th recording liquid to each of the plural common liquid chambers 3. A common liquid chamber separating groove 7 is formed in a common liquid chamber separating wall 6 arranged to divisionally separate the plural common liquid chambers 3 from each other. The common liquid chamber separating groove 7 separates the common liquid chambers 3 from each other by filling the interior of the common liquid separating groove 7 with a filler. A sealant injecting port 8 for injecting a sealant to the common liquid chamber separating groove 7 is formed in an end portion of the common liquid chamber separating groove 7. A temporary stopping leg 9 is arranged in each of both end portions of a joining face (hereinafter, this face is also simply called a joining face) of the second substrate 1 joined to the first substrate such that the second substrate 1 is projected from this joining face. This temporary stopping leg 9 is arranged to stabilize the second substrate 1 when the second substrate 1 is joined to the first substrate. The temporary stopping leg 9 is arranged such that this temporary stopping leg 9 is separated from each of the common liquid chambers 3 at left-hand and right-hand ends of the second substrate 1 through a common liquid chamber frame 10 (see Fig. 1B).

[0034] A face opposed to the joining face arranging the plural common liquid chambers 3, the liquid flow path groove 4, the common liquid chamber separating groove 7, etc. thereon is here a face (hereinafter, this face is also simply called a pressing face) pressed by an unillustrated pressing member such as a spring, etc. A thin wall portion 11, a concave portion groove 12 and plural convex portions 13 are formed on the pressing face shown in Fig. 1A. The thin wall portion 11 is set to be thin in a portion corresponding to the common liquid chamber frame 10 in each of both end portions of the second substrate 1. The concave portion groove 12 is arranged in a position of the pressing face corresponding to the common liquid chamber separating wall 6 for divisionally separating the common liquid chambers 3 from each other. The concave portion groove 12 is formed in a trapezoidal shape in section, etc. extending along a liquid discharging direction. The plural convex portions 13 are formed in an elongated shape along the liquid discharging direction in a portion corresponding to an arranging position of the liquid flow path groove 4. The plural concave portions 13 are arranged along an arranging direction of the liquid flow path groove 4. The plural concave portions 13 receive pressing force of the pressing member such as a spring, etc. for pressing and joining the second substrate 1 to the first substrate. In this way, warp and deformation of the second substrate 1 or dispersion of the pressing force in the arranging direction of the liquid flow path groove due to dispersion in accuracy of the pressing member is dispersed by receiving the pressing force of the pressing member at plural points. An entire range of a liquid flow path area is pressed by the uniform pressing force and a joining property of the liquid flow path area of the second and first substrates is improved. A step difference portion 15 is formed in a corner portion of a peripheral portion of a liquid supply port 5 on the pressing face, a peripheral portion of the concave portion groove 12 or the sealant injecting port 8, etc. when the second substrate 1 is molded by resin. A slight step difference and an inclination are formed in the step difference portion 15 to restrain generation of burrs, etc. In particular, when a burr is formed around the liquid supply port 5, there is a fear of record impossibility since this burr is mixed into the recording liquid during a recording operation. The step diff rence portion 15 is arranged to prevent such a situation. An operation of the concave portion groove 12 will be described later.

[0035] As mentioned above, in the second substrate of this embodiment, the common liquid chamber frame 10 extends outward from the common liquid chamber 3 located at each of both ends of the plural common liquid chambers 3 in view of resin molding and a joining close attaching property as described later. Namely, the common liquid chamber frame 10 located in each of both side end portions of the second substrate 1 is molded with a certain width to preferably mold the temporary stopping leg 10. In such a second substrate 1, the common liquid chamber 3 is dug into a central portion of the second substrate 1 so that this central portion is set to be thin. However, portions of the common liquid chamber frame 10 located in each of both the side end portions are set to be thick. Ununiformity of the thickness caused in this second substrate 1 causes slight warp and winding at a molding time of the second substrate 1. The warp and the winding of this second substrate 1 are normally compulsorily restrained by a load of the pressing member such as a spring, etc., and the first substrate and the second substrate 1 are joined to each other. However, when the warp and the winding of the second substrate are too large, it is difficult to make both the substrates sufficiently come in close contact with each other.

[0036] Therefore, in the second substrate of this embodiment, the thickness of a portion 11 opposed to the common liquid chamber frame 10 in each of both the side end portions of a joining face joined to the first substrate is set to be thin on the pressing face. These thin wall portions 11 in both the side end portions are arranged in a bilateral symmetrical shape with respect to a central line of the second substrate. Concretely, both end portions of the second substrate 1 on its pressing face are cut by about 2.35 mm × 1.84 mm × 0.4 mm ((x1)×(y1)×(z1) in Fig. 1A) and are set to the thin wall portions 11.

[0037] Thus, the thickness of the portion 11 opposed to the common liquid chamber frame 10 in each of both the side end portions on the joining face joined to the first substrate is set to be thin so that warp of the second substrate 1 can be reduced. Further, warp of the second substrate and winding of the second substrate on the joining face to the first substrate can be reduced by arranging the thin wall portions 11 in both the side end portions in the bilateral symmetrical shape with respect to the central line of the second substrate 1. Molding stability is also improved at a molding time of the second substrate.

[0038] Further, the common liquid chamber frame 10 extends further outward from each of common liquid chambers 3 located at both ends of the plural common liquid chambers 3. This extending portion is set to be thin and

these thin portions. Thus, warp of the second substrate can be reduced and a mold releasing property from a die at a molding time can be improved. Further, a stabler molding property can be obtained by arranging these digging-in concave portions with bilateral symmetry with respect to a central line of the second substrate.

(Third embodiment)

[0049] Fig. 3 is a conceptual view seen from a liquid discharging side to show the relation of second and first substrates in a liquid injecting recording head in a third embodiment of the present invention. In this embodiment, members and portions similar to those in the above embodiments are also designated by the same reference numerals, and a detailed explanation of these members and portions is omitted here.

[0050] In Fig. 3, similar to the second substrate of the above first and second embodiments, a second substrate 1 has an orifice plate 2 in which plural discharging ports 18 are formed. Plural liquid flow path grooves 4, plural common liquid chambers 3, and a common liquid chamber separating wall 6 and a common liquid chamber separating groove 7 for divisionally separating the common liquid chambers 3 from each other are formed on a joining face of the second substrate joined to a first substrate 31. Further, a temporary stopping leg 9 is formed in each of both end portions of the joining face. A concave portion groove 12, a thin wall portion 11, etc. are formed on a pressing face opposed to the joining face.

[0051] Strongest force is applied to a joining start point 25 when the first substrate 31 and the second substrate 1 are joined to each other. Accordingly, the joining start point 25 tends to be a start point of deformation of the second substrate 1. The joining start point 25 corresponds to each of both end portions 32 of the first substrate 31. In Fig. 3, reference numeral A designates a length of the second substrate in an arranging direction of the liquid flow path grooves on the joining face. Reference numeral B designates a length of the first substrate 31. Reference numeral C designates an arranging length of discharging ports 18 for discharging a recording liquid (e.g., the length of a liquid discharging functional portion functioning in liquid discharge). It is generally necessary to set the length A to be longer than the length B so as to join the second substrate 1 to the first substrate 31. However, when the length A is set to be too long, both the substrates are easily joined to each other, but a liquid injecting recording head itself is large-sized. As a result, a liquid injecting recording head printer is large-sized. In contrast to this, when the length B is conversely set to be short, the liquid injecting recording head is made compact. However, when the length B is excessively close to the arranging length C of the discharging ports 18, the joining start point 25 approaches the discharging ports 18. Therefore, when the second substrate 1 is deformed, the discharging ports 18 are also deformed by this deformation of the second substrate 1. Thus, a liquid reaching accuracy is shifted only in a printing end portion in the liquid injecting recording head in which the lengths B and C are close to each other. When such a phenomenon is caused, linearity of one thin straight line is lost in its printing case even when the reaching accuracy of the recording liquid in the printing end portion lies within a standard accuracy but is separated from an average of the entire reaching accuracy.

[0052] Therefore, in this embodiment, the length A of the second substrate in the arranging direction of the liquid flow path groove on the joining face of the second substrate 1 joined to the first substrate 31 is set to be sufficiently longer than the arranging length (the length of the liquid discharging functional portion) C of the discharging ports 18 for discharging the recording liquid. Further, this length A is set to be longer than the length B of the first substrate 31. In such a construction, positions of the discharging ports 18 for discharging the recording liquid can be separated from a position of the joining start point 25 at which an end portion of the first substrate 31 as a portion concentrated most strongly in stress in pressing and joining of the second substrate 1 to the first substrate 31 is joined to the second substrate 1. Therefore, if stress is concentrated at the joining start point 25, the discharging ports 18 are sufficiently separated from this concentrated portion so that no liquid discharge from the discharging ports 18 is influenced by this stress concentration. As a result, when the second substrate 1 and the first substrate 31 are particularly joined to each other by giving mechanical biasing force, an amount of this biasing force (load) can be increased.

[0053] Each of the lengths A, B and C is arbitrarily set and an optimum relation is calculated by sufficiently considering the above matters. Thus, it is confirmed that a relation satisfying a condition of $(A-C)/2 \geq 1.1$ mm, and $(B-C)/2 \geq 0.825$ mm is best.

[0054] For example, a printing operation is performed by manufacturing the liquid injecting recording head using the second substrate having the relation of A=14.9 mm, B=14.4 mm and C=11.241 mm. In this case, the linearity of a straight line is excellent in comparison with a liquid injecting recording head manufactured by using a second substrate having a similar shape and the relation of A=14.9 mm, B=11.4 mm and C=11.241 mm.

(Fourth embodiment)

[0055] Fig. 4A is a perspective view of a second substrate constituting a liquid injecting recording head in a fourth embodiment of the present invention. Fig. 4B is a partial sectional view showing this second substrate by partially breaking this second substrate. In this embodiment, members and portions similar to those in the above embodiments are also designated by the same reference numerals, and a detailed explanation of these members and portions is omitted here.

[0056] In this embodiment, a concave portion groove 12 is formed in a trapezoidal shape, etc. in section. The concave portion groove 12 extends entirely along a liquid discharging direction in the position of a pressing face corresponding to a common liquid chamber separating wall 6 for divisionally separating common liquid chambers 3 from each other. Thus, a portion of the common liquid chamber separating wall 6 thick in the second substrate 1 can be

reference point (marking) of the first substrate 31 is measured over the concave portion 23, and a position of the concave portion 23 and the certain specific reference point of the first substrate 31 are aligned with each other. Thus, the position of the concave portion 23 and the certain specific reference point of the first substrate 31 can be more accurately aligned with each other.

(Sixth embodiment)

[0066] In each of the above embodiments, the second substrate 1 having three common liquid chambers 3 is used and is manufactured as a liquid injecting recording head for color and is evaluated. However, the above embodiments (except for the fourth embodiment in which the concave groove is formed in a position opposed to the common liquid chamber separating wall) are not limited to the liquid injecting recording head for color. As shown in Figs. 6A and 6B, similar effects are also obtained even in a liquid injecting recording head for a monochromatic color, especially black into which a second substrate 1A having only one common liquid chamber 3 is assembled. It is particularly preferable to adopt the above third embodiment in the liquid injecting recording head for black in which many straight lines are printed and recorded.

[0067] A liquid injecting recording head is constructed by a first substrate in which a discharging energy generating element for generating discharging energy for discharging a recording liquid is formed, and a second substrate which has a liquid flow path groove forming a liquid flow path by joining this liquid flow path groove to the first substrate, a concave portion communicated with the liquid flow path groove and forming a common liquid chamber for temporarily holding the recording liquid, and an orifice plate communicated with the liquid flow path groove and having a discharging port for discharging the recording liquid. The liquid injecting recording head is constructed by joining the first and second substrates to each other in a form in which the discharging energy generating element and the liquid flow path groove correspond to each other. The liquid injecting recording head is characterized in that both end portions of a face opposed to a face of the second substrate joined to the first substrate are formed to be thin.

Claims

1. A liquid injecting recording head constructed by a first substrate in which a discharging energy generating element for generating discharging energy for discharging a recording liquid is formed, and a second substrate which has a liquid flow path groove forming a liquid flow path by joining this liquid flow path groove to the first substrate, a concave portion communicated with the liquid flow path groove and forming a common liquid chamber for temporarily holding the recording liquid, and an orifice plate communicated with said liquid flow path groove and having a discharging port for discharging the recording liquid; the liquid injecting recording head being constructed by joining said first and second substrates to each other in a form in which said discharging energy generating element and said liquid flow path groove correspond to each other;
   the liquid injecting recording head being characterized in that both end portions of a face opposed to a face of said second substrate joined to said first substrate are formed to be thin.

2. A liquid injecting recording head according to claim 1, wherein both the thin end portions of a face opposed to a face of said second substrate joined to said first substrate are arranged with bilateral symmetry with respect to a central line of said second substrate.

3. A liquid injecting recording head constructed by a first substrate in which a discharging energy generating element for generating discharging energy for discharging a recording liquid is formed, and a second substrate which has a liquid flow path groove forming a liquid flow path by joining this liquid flow path groove to the first substrate, a concave portion communicated with the liquid flow path groove and forming a common liquid chamber for temporarily holding the recording liquid, and an orifice plate communicated with said liquid flow path groove and having a discharging port for discharging the recording liquid; the liquid injecting recording head being constructed by joining said first and second substrates to each other in a form in which said discharging energy generating element and said liquid flow path groove correspond to each other;
   the liquid injecting recording head being characterized in that digging-in concave portions are formed in both end portions of a face opposed to a face of said second substrate joined to said first substrate.

4. A liquid injecting recording head according to claim 3, wherein said digging-in concave portions are arranged with bilateral symmetry with respect to a central line of said second substrate.

5. A liquid injecting recording head according to claim 1 or 2, wherein digging-in concave portions are formed in both the thin end portions of a face opposed to a face of said second substrate joined to said first substrate.

6. A liquid injecting recording head constructed by a first substrate in which a discharging energy generating element for generating discharging energy for discharging a recording liquid is formed, and a second substrate which has a liquid flow path groove forming a liquid flow path by joining this liquid flow path groove to the first substrate, a concave portion communicated with the liquid flow path groove and forming a common liquid chamber for temporarily holding the recording liquid, and an orifice plate communicated with said liquid flow path groove and having a discharging port for discharging the recording liquid; the liquid injecting recording head being constructed by joining said first and second substrates to each other in a form in which said

20. A liquid injecting recording head according to claim 18 or 19, wherein said concave portion groove is formed in a bilateral symmetrical shape with respect to a central line of the concave portion groove.

21. A liquid injecting recording head according to any one of claims 18 to 20, wherein said concave portion groove is formed in a trapezoidal shape in section.

FIG. 2A

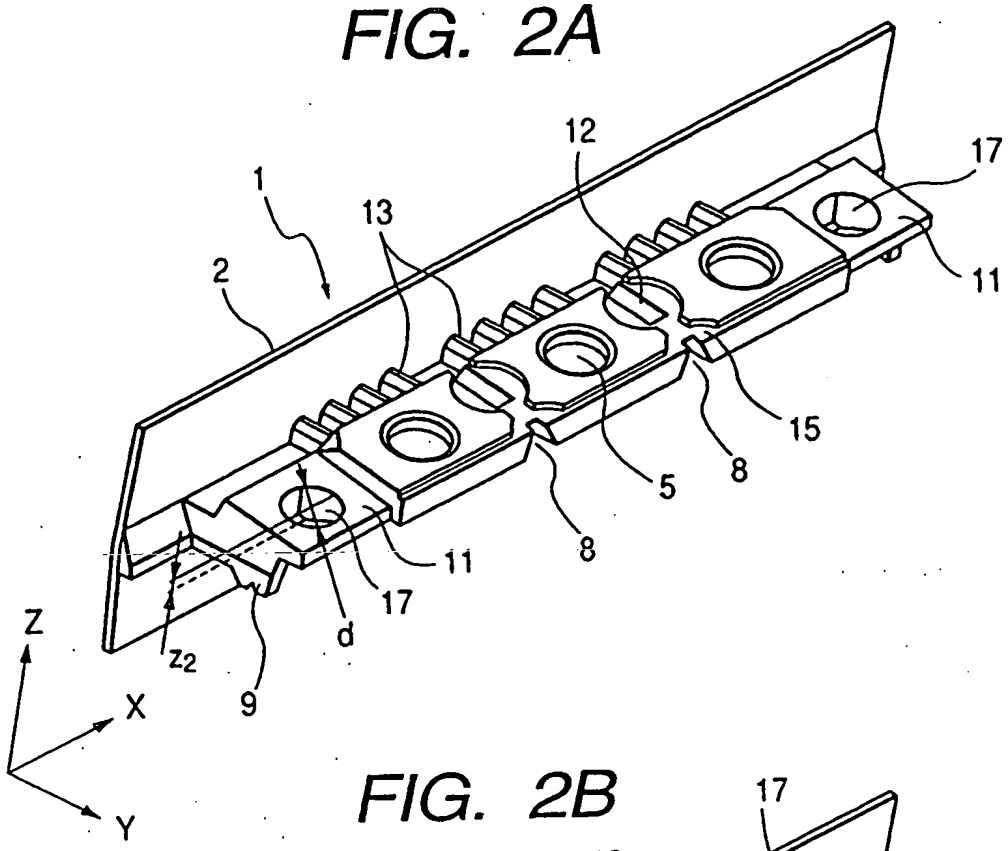

FIG. 2B

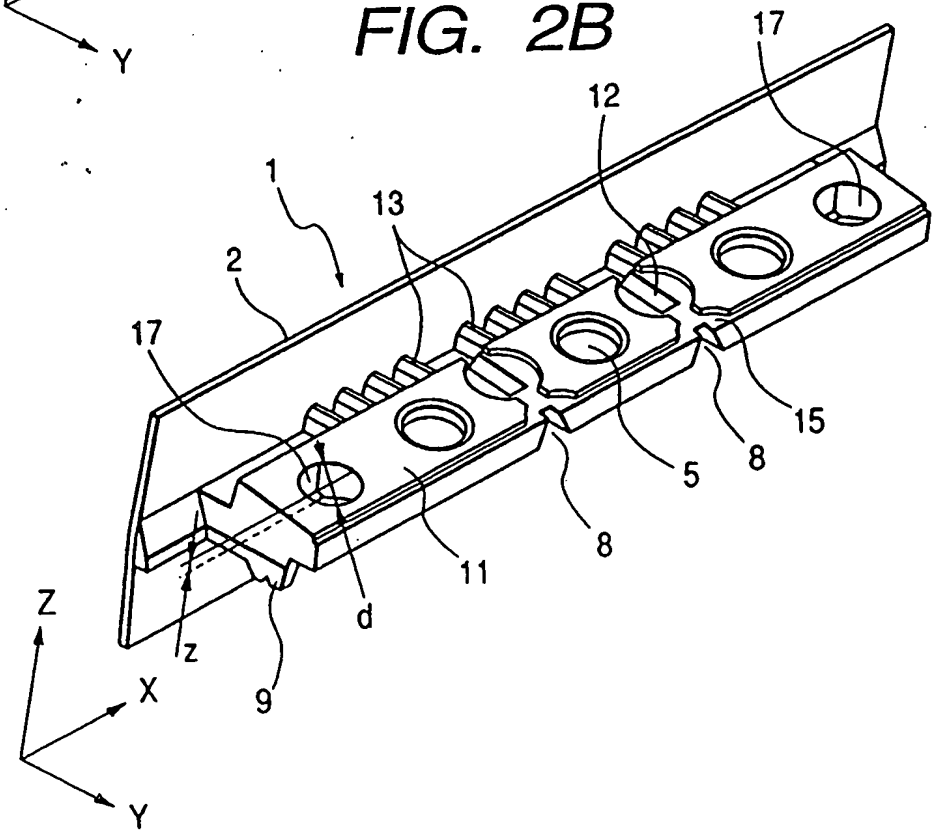

FIG. 4A

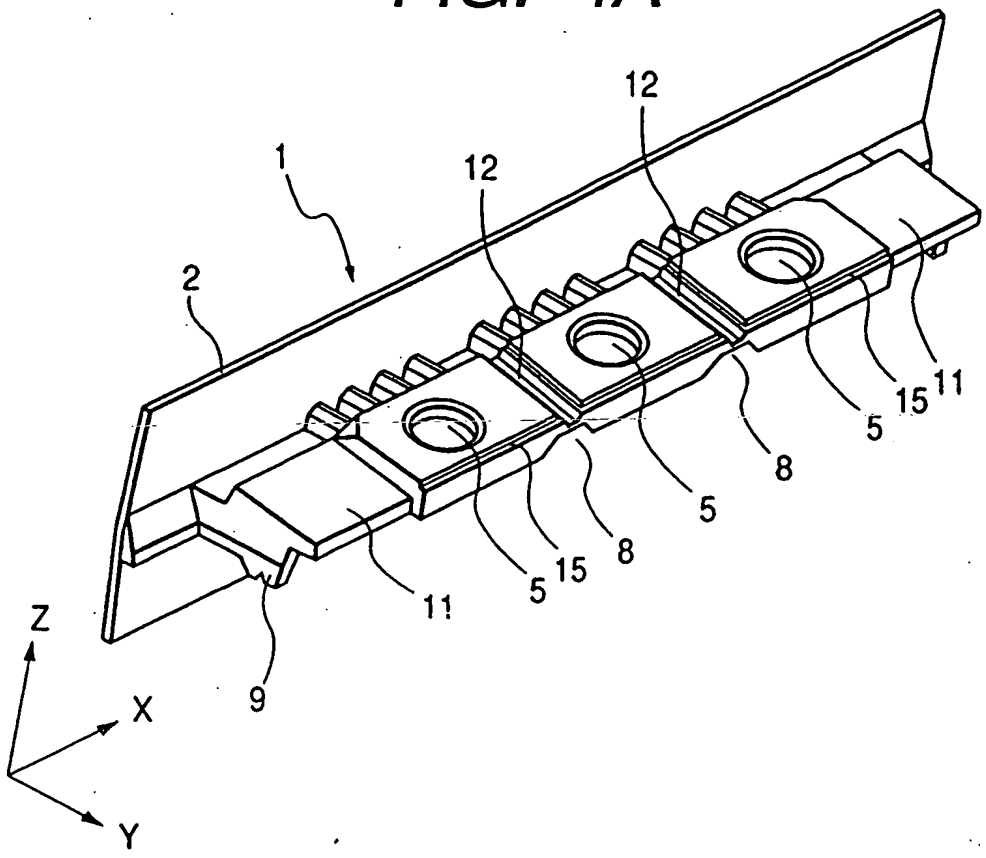

FIG. 4B

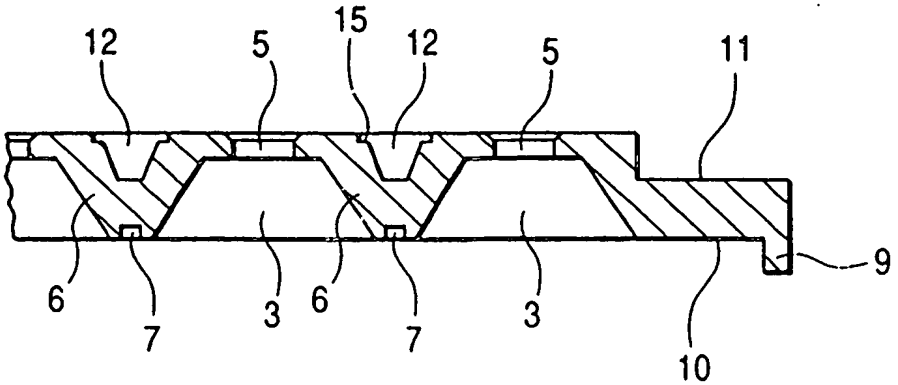

FIG. 6A

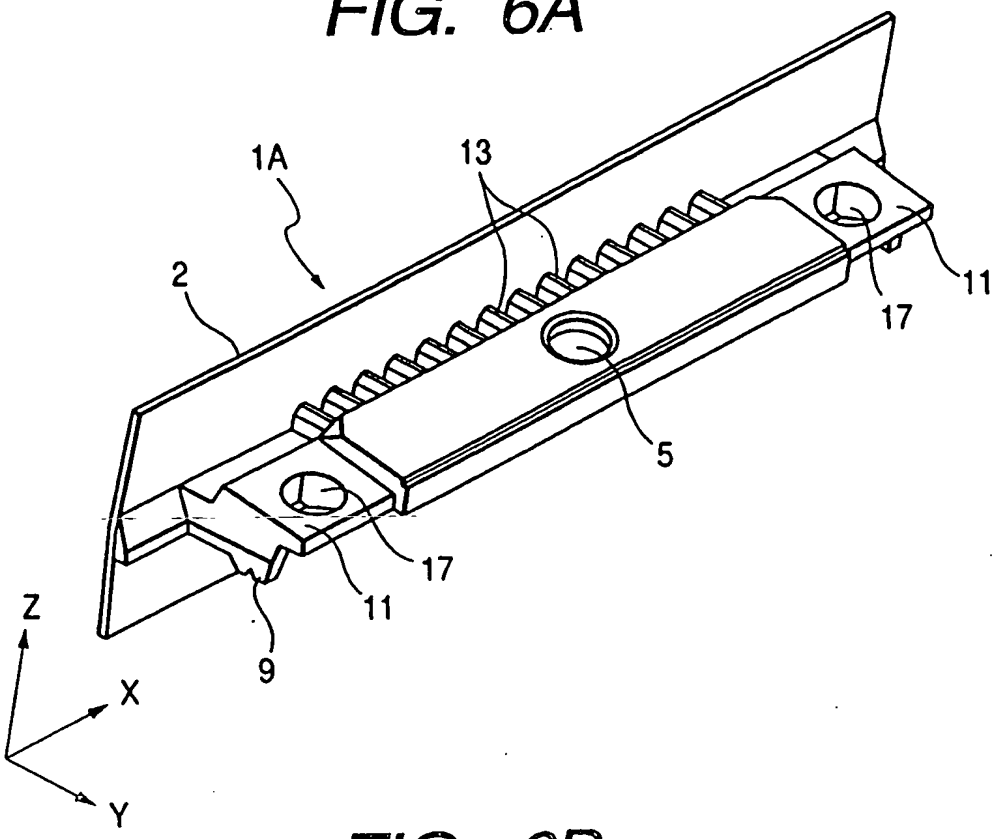

FIG. 6B